SECTION I

CONSTRUCTION LAYOUT AND MEASUREMENTS
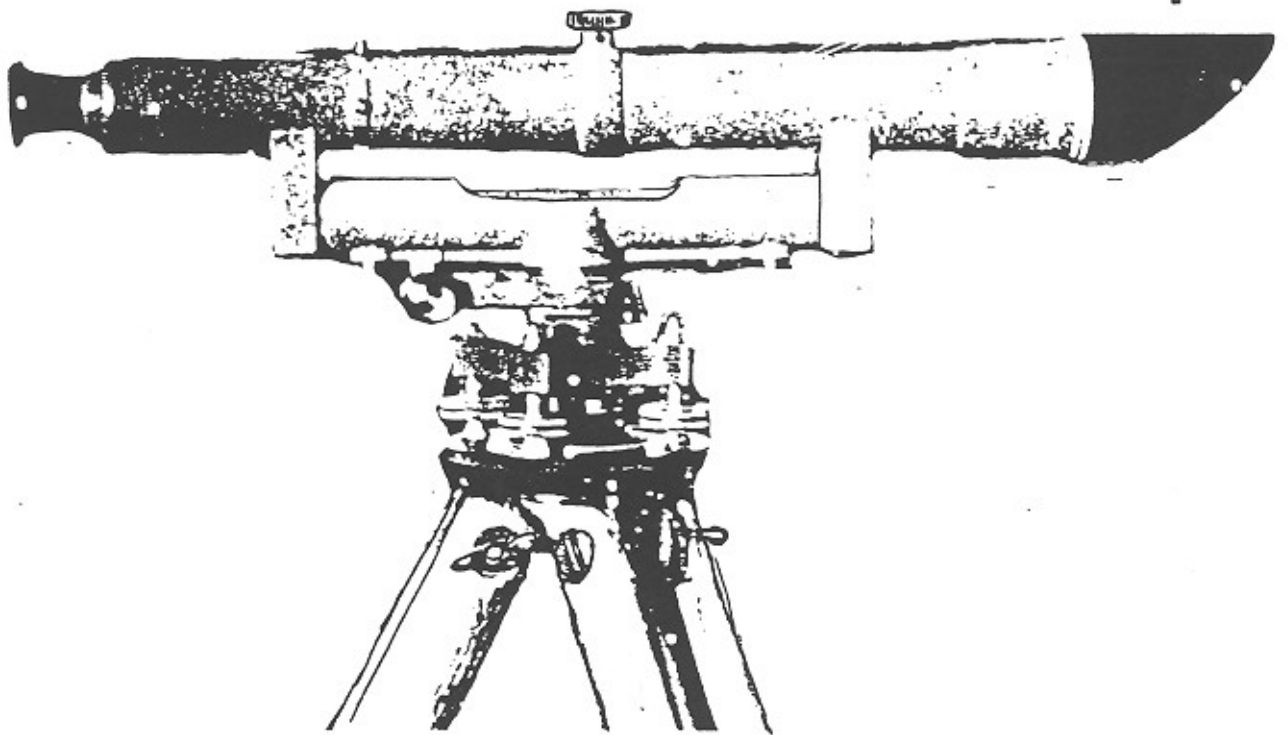
CHAPTER 1

CONSTRUCTION LAYOUT AND MEASUREMENTS

INTRODUCTION   This course is intended to refresh and improve the
inspector's ability to solve problems and to do various
calculations required in construction layout and
determining pay quantities.

NOTE: To be effective in this course a calculator capable of
at least simple trigonometry functions (sin,cos,
tan) will be needed. An understanding of trigonometry
will not be required, as fill in the blank formulas
will be provided.

DEFINITIONS   In our studies, first we need to discuss the
definitions of the generally used figures.

POLYGON   A closed figure bounded by straight lines lying in the
same plane is known as a polygon. The sum of the
interior angles of a closed polygon is equal to:

$$(N - 2)\ 180 \text{ degrees}$$

where N is the number of sides. Thus, the sum of the
interior angles of a triangle is 180 degrees,
rectangle, 360 degrees, five sided figure 540 degrees,
etc.

TRIANGLE   A polygon of three sides

**RIGHT
TRIANGLE**   A triangle which has one right angle (90 degrees)

**ISOSCELES
TRIANGLE**   A triangle which has two equal sides and two equal
angles.

**EQUILATERAL
TRIANGLE**   A triangle which has three (3) equal sides and
three(3)equal angles.

**OBLIQUE
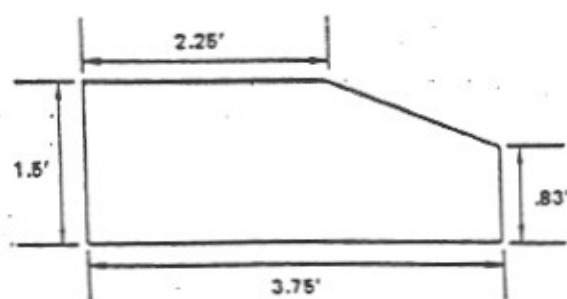TRIANGLE**   A triangle which has no right angle and no two
sides equal.

CONGRUENT TRIANGLES   Two (2) triangles are congruent if their corresponding sides and corresponding angles are equal.

SIMILAR TRIANGLES   Two triangles are similar if their corresponding angles are equal and their corresponding sides are proportional.

RECTANGLE   A four-sided polygon whose angles are right angles. A square is a rectangle whose four sides are equal.

TRAPEZOID   A four sided polygon which has two (2) parallel sides and two (2) NON - PARALLEL SIDES.

CIRCLE   A closed plane curve, all points of which are equidistant from a point called the center.

RADIUS   The distance from the center of the circle to any point on the circle.

DIAMETER   The distance across the circle through the center.

CHORD   A straight line between two points on a circle.

ARC   Any part of the circle.

SEMI-CIRCLE   An arc equal to one half the circumference of a circle.

AREA
DEFINITIONS   Area is the surface within a set of lines. Area is
                   measured in square units, square inches, square
                   feet,square miles, etc.

RECTANGLE   The area is equal to the product of the length and the
                   width. A = L X W

TRIANGLE   The area is expressed in terms of its base and altitude.
                   Any side of a triangle can be called the base.
                   The altitude is the perpendicular distance from the base
                   to the vertex opposing the base. (An angle maybe
                   defined
                   as the space between two lines diverging from a common
                   point: the point is called the vertex.)
                   The area of any triangle is : A = 1/2 B x H

RIGHT   The area is equal to one half the product of the base
TRIANGLE   and the altitude.

AREA OF A   If the length of the three sides of a triangle are
TRIANGLE WITH known, the area can be found from:
KNOWN SIDES $A=\sqrt{-s\ (s-a)\ (s-b)\ (s-c)}$
                           Where A=Area
                                 s= 1/2 the perimeter
                                 a,b,c, = the lengths of each of the sides

AREA OF A   The area of a trapezoid is equal to the average width
TRAPEZOID   times the altitude, or expressed in another way, the area
                   is the sum of the bases times the height.

AREA OF A   The area of a circle is always - times the square of its
CIRCLE   radius.

                       $A= \Pi\ r^2$

RISE AND   Area = C x B x Coefficient
CHORD

COMPOSITE   Irregular shaped areas can be divided into components
AREAS   which we have discussed, the areas of which can be found.
                   This method is very helpful where the inspector is
                   measuring sod, concrete driveways, etc.

PROBLEMS

1. Find the area of a right triangle with a base of 12 inches and an altitude of 8 inches.

2. Find the number of square feet of wall board needed to cover the walls and ceiling of a room 24 ft. long, 16 ft. wide and 8 ft. high. Find the number of 4 ft. by 8 ft. sheets needed.

3. Find the cross section area of a ditch of trapezoidal cross section with top width of 28 ft. bottom width of 4 ft. and depth of 6 ft.

4. Find the cross section area of a highway fill of trapezoidal cross section with top width of 44 ft., base width of 92 ft. and height of 8 ft.

5. Find the area of a circle of a 20 ft. radius.

6. Find the area of a 10 ft. diameter circle.

7. Find the area of a 60 degree sector of a 6 inch circle.

S. Find the area of the segment whose arc subtends an angle of 90 degrees in a 12 foot circle (12 ft. diameter).

9. Find the area of a triangle with sides 18 ft, 12 ft and 10 ft.

10. Divide the figures into component parts, then find the total area by either adding the areas of the component parts or by subtracting areas from a larger area which includes the area shown.
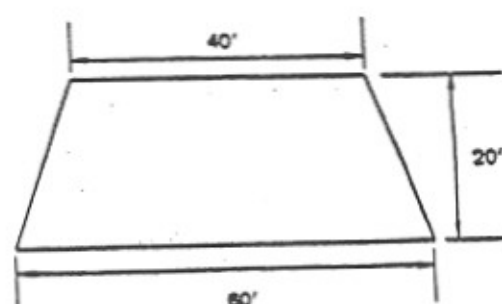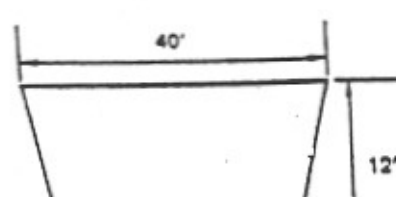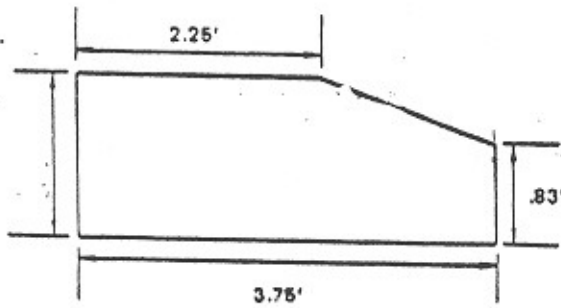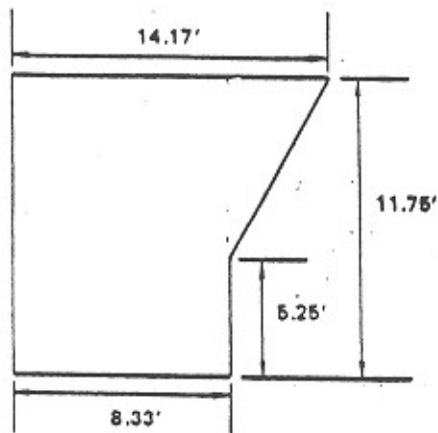
Example:

(a)

$A = (3.75)(1.5) - 1/2(1.50)(0.67)$

$= 5.1 \ ft^2$

(b)

1 - 4

Additional Figures, Find the Areas:

(c)

2.25'

.83'

3.75'

(d)

14.17'

11.75'

5.25'

8.33'

(e)

8.75'

10.67'

10.17'

(f)

14"

12"

(g)

6"

6"
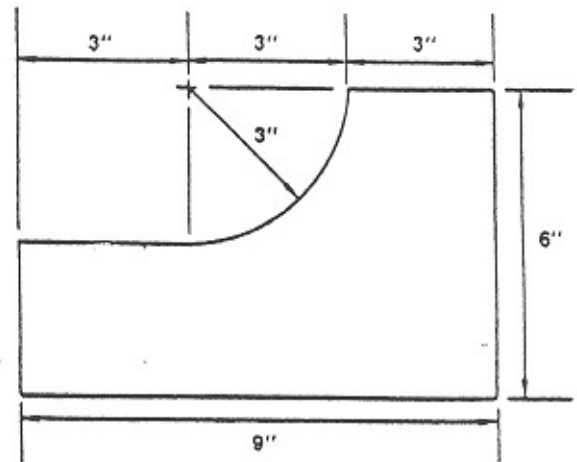
18"
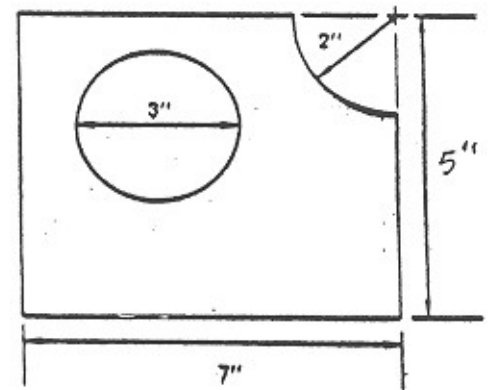
(h)
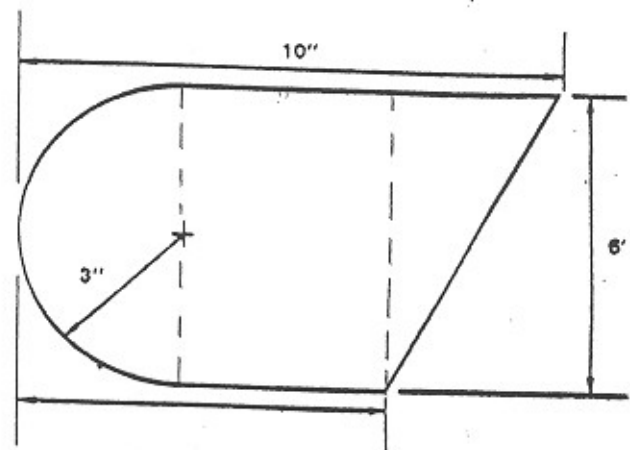
3"   3"   3"

3"

6"

9"

(i)

2"

3"

5"

7"

(j)

10"

3"

6'
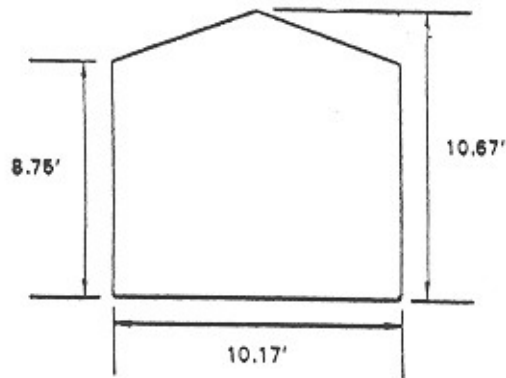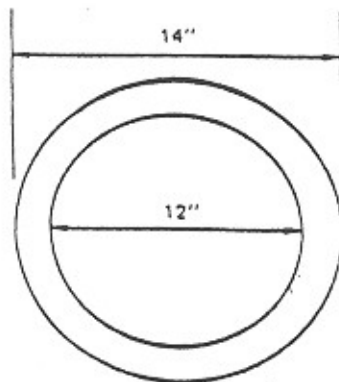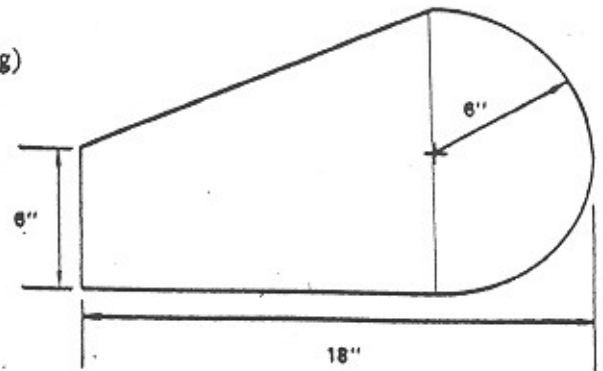
ACCURACY OF
CALCULATIONS
The degree of accuracy is furnished to show the required accuracy for measurements and calculations. In rounding off, all quantities less than an exact split will be reduces to the next lower unit. Exact splits will be rounded to the nearest even unit. Quantities more than an exact split will be increased to the next larger unit.

For example:

.33 would be rounded to .3   .43 would be rounded to .4

.35 would be rounded to .4   .45 would be rounded to .4

.38 would be rounded to .4   .48 would be rounded to .5

The degree of accuracy will be based on the dollar value of the bid item. All measurements will be to the nearest tenth. Calculations as well as final pay quantity round offs will be carried out as shown below. Exceptions to this rule are listed following this table.

DEGREE OF
ACCURACY
TABLE

UNIT PRICE BID AMOUNT	FIELD MEASUREMENTS	CALCULATIONS &SUB TOTALS	FINAL PAY QUANTITY
$ 0 - 9.99	0.1 unit	0.1 unit	1 unit
$10 - 99.9	0.1 UNIT	0.01 unit	.1 unit
$100 -999.	0.1 unit	0.01 unit	.01unit
$1000 &	0.1 unit	0.001 unit	.001 unit

A unit as shown in this table shall be the proposal unit.

EXCEPTIONS
Weigh tickets are considered original notes for many items and will be made to the nearest 100 lbs. calculations and final pay quantity will follow the degree of accuracy table.

Pavement striping and pipe (except concrete pipe) will be measured and calculated to the nearest foot. See applicable specification for measurement of concrete pipe.

Seed and fertilizer will. be weighed to the nearest pound.

Items whose proposal unit is each or lump sum would naturally be measured, counted and computed to that whole unit.

**Accuracy of
Calculations
(cont'd)**

Linear grading should be field measured to the nearest 0.001% of the unit, with calculations, sub totals and final pay quantity as shown in the accuracy table.

Field measurements, calculations, subtotals and final pay quantity on herbicide contracts will be in the nearest unit.

TABLE 108
AREAS OF CIRCULAR SEGMENTS
TABLE FOR RATIOS OF RISE & CHORD
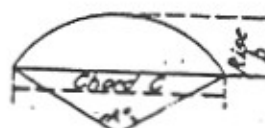
Coefficient is given opposite the quotient of b divided by C

AREA = C x b x Coefficient

A°	Coefficient	b/C	A°	Coefficient	b/C	A°	Coefficient	b/C	A°	Coefficient	b/C
1	.6667	.0022	46	.6722	.1017	91	.6895	.2097	136	.7239	.3373
2	.6667	.0044	47	.6724	.1040	92	.6901	.2122	137	.7249	.3404
3	.6667	.0066	48	.6727	.1063	93	.6906	.2148	138	.7260	.3436
4	.6667	.0087	49	.6729	.1086	94	.6912	.2174	139	.7270	.3469
5	.6667	.0109	50	.6732	.1109	95	.6918	.2200	140	.7281	.3501
6	.6667	.0131	51	.6734	.1131	96	.6924	.2226	141	.7292	.3534
7	.6668	.0153	52	.6737	.1154	97	.6930	.2252	142	.7303	.3557
8	.6668	.0175	53	.6740	.1177	98	.6936	.2279	143	.7314	.3600
9	.6669	.0197	54	.6743	.1200	99	.6942	.2305	144	.7325	.3633
10	.6670	.0218	55	.6746	.1224	100	.6948	.2332	145	.7336	.3666
11	.6670	.0240	56	.6749	.1247	101	.6954	.2358	146	.7348	.3700
12	.6671	.0262	57	.6752	.1270	102	.6961	.2385	147	.7360	.3734
13	.6672	.0284	58	.6755	.1293	103	.6967	.2412	148	.7372	.3768
14	.6672	.0306	59	.6758	.1316	104	.6974	.2439	149	.7384	.3802
15	.6673	.0328	60	.6761	.1340	105	.6980	.2466	150	.7396	.3837
16	.6674	.0350	61	.6764	.1363	106	.6987	.2493	151	.7408	.38
17	.6674	.0372	62	.6768	.1387	107	.6994	.2520	152	.7421	.3906
18	.6675	.0394	63	.6771	.1410	108	.7001	.2548	153	.7434	.3942
19	.6676	.0416	64	.6775	.1434	109	.7008	.2575	154	.7447	.3977
20	.6677	.0437	65	.6779	.1457	110	.7015	.2603	155	.7460	.4013
21	.6678	.0459	66	.6782	.1481	111	.7022	.2631	156	.7473	.4049
22	.6679	.0481	67	.6786	.1505	112	.7030	.2659	157	.7486	.4085
23	.6680	.0504	68	.6790	.1529	113	.7037	.2687	158	.7500	.4122
24	.6681	.0526	69	.6794	.1553	114	.7045	.2715	159	.7514	.4159
25	.6682	.0548	70	.6797	.1577	115	.7052	.2743	160	.7528	.4196
26	.6684	.0570	71	.6801	.1601	116	.7060	.2772	161	.7542	.4233
27	.6685	.0592	72	.6805	.1625	117	.7068	.2800	162	.7557	.4270
28	.6687	.0614	73	.6809	.1649	118	.7076	.2829	163	.7571	.4308
29	.6688	.0636	74	.6814	.1673	119	.7084	.2858	164	.7586	.4346
30	.6690	.0658	75	.6818	.1697	120	.7092	.2887	165	.7601	.4385
31	.6691	.0681	76	.6822	.1722	121	.7100	.2916	166	.7616	.4424
32	.6693	.0703	77	.6826	.1746	122	.7109	.2945	167	.7632	.4463
33	.6694	.0725	78	.6831	.1771	123	.7117	.2975	168	.7648	.4502
34	.6696	.0747	79	.6835	.1795	124	.7126	.3004	169	.7664	.4542
35	.6698	.0770	80	.6840	.1820	125	.7134	.3034	170	.7680	.4582
36	.6700	.0792	81	.6844	.1845	126	.7143	.3064	171	.7696	.4622
37	.6702	.0814	82	.6849	.1869	127	.7152	.3094	172	.7712	.4663
38	.6704	.0837	83	.6854	.1894	128	.7161	.3124	173	.7729	.4704
39	.6706	.0859	84	.6859	.1919	129	.7170	.3155	174	.7746	.4745
40	.6708	.0882	85	.6864	.1944	130	.7180	.3185	175	.7763	.4787
41	.6710	.0904	86	.6869	.1970	131	.7189	.3216	176	.7781	.4828
42	.6712	.0927	87	.6874	.1995	132	.7199	.3247	177	.7799	.4871
43	.6714	.0949	88	.6879	.2020	133	.7209	.3278	178	.7817	.4
44	.6717	.0972	89	.6884	.2046	134	.7219	.3309	179	.7835	.4
45	.6719	.0995	90	.6890	.2071	135	.7229	.3341	180	.7854	.5000